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SUBJECT The Ndola Accident by Bengt-Ake Bengs					
ACTION REQUIRED - REFERENCES FYI					

1. We attach a 20-page brochure expressing "A theory as to the cause of the accident and facts not accounted for and not known to the public" concerning the Ndola accident in which Dag Hammarskjöld, Secretary General of the United Nations was killed. [REDACTED]

2. [REDACTED] the author [REDACTED] very sympathetic and apparently knowledgeable fellow. He is about 45 years of age, married and presently suffering from some sort of heart trouble which leaves him tired and somewhat emaciated.

Attachment:
Brochure a/s/a

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THE NDOLA ACCIDENT

A theory as to the cause of the accident

and

Facts not accounted for and not known to the public

The present work contains the thoughts I have had in mind for a few years. It has been my hope that somebody else, individual or authority, would speak out on the matter. As this has not been the case, I have found it necessary to write down my thoughts.

The Ndola accident made me interested at once. I had myself been engaged in flying for the United Nations in the Congo, and in the same type of operations. I had 4000 piloting hours on the type of equipment involved in the accident, and I

had previous experience from flying on scheduled routes in Africa.

The rumours set about and the way the case was dealt with by the press soon made it clear that the accident had become political business.

The investigation reports proved to be something quite apart from the about 200 other accident reports I have studied.

The accident is regarded as having been caused by a type of pilot misjudgment which, although not uncommon, is not attended to with eligible energy.

Stockholm, January 1966

Osby

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Introduction

On the night between the 17th and the 18th September 1961 an airplane crashed near Ndola in Northern Rhodesia (present day Zambia). The plane — a DC-6B owned and operated by the Swedish charter company Transair — carried 16 persons including the crew. None of them survived. One of the passengers was Dag Hammarskjöld, Secretary General of the United Nations.

The accident caused great public concern and rumours were immediately set about. The situation called for a thorough investigation and a resolute and final statement as to the cause of the accident. As it was never aimed for such a target we are to-day in the same position as if there had been no investigation at all.

On the other hand, expert pilots who have made a careful study of the subject

are pretty sure about what happened. They say the accident was due to misjudgment by the pilot, and they can also explain how it came about.

No more need to be said before one concludes that the investigation was not made, and the reports were not worked out in a proper way.

No sooner was the accident announced over the radio than I was called by a newspaper requesting my views on flying in the Congo. The reason was that until a few months before the accident I had been serving as captain on a plane chartered by the United Nations. The service which implied transportation of UN officials was maintained by my company — SAS — for one year. Two months before the Ndola accident Transair took over with their newly bought DC-6B.

Facts missing

One fact immediately struck me as remarkable: the accident occurred during the night. The only night flying the SAS pilots did in the Congo was on the last part of flights bound for the home base, Léopoldville — a well equipped airport. Other night flying was considered a hazard as radio aids for navigation and communication were insufficient. Apart from this, landings at unknown airports during night are never recommendable. To the Ndola crew the aircraft type was quite new and so was flying in Africa. Yet night flying had been put into system. On the night before the accident a flight to Elisabethville was made. These circumstances are not discussed in any of the accident reports.

Other facts later came out. The pilots of the Ndola crew had flown in excess of the flight time limitations prescribed by the Swedish Civil Board of Aviation. The limit dictated was 125 hours a month. The limit prescribed by the crew union agreement

was 100 hours a month. A strict adherence to the crew union's directions as to maximum duty and minimum rest time made it almost impossible to get into the neighbourhood of 100 hours a month. The precepts have come into being in the interest of flight safety. The pre-accident flight time of the Ndola crew members is not accounted for in any of the reports. There is no description whatsoever of duty and rest time during the days preceding the accident. The figures, however, exist though only those of the captain have leaked out.

During the 20 days immediately before the accident the captain flew 158 hours. His flight time in August was 119 hours. Of his last 24 hours 17 were spent on flight duty.

There is reason to believe that the major part of the crew did not have any real rest during the last 36 hours prior to the accident.

A higher than normal utilization of the pilots is profitable for the company, and

for the pilots too — if they accept extra pay for extra hours.

In 1959 the Swedish Pilots Association discovered a large number of violations of the official flight time limitations within Transair. The Board of Aviation had failed in its supervision of the company. It failed again regarding the Congo operations in 1961.

Personal data including aviation background and conditions of duty during the days preceding the accident belong to any accident report. In the Ndola reports this information is missing. Had it been there the reports would have looked otherwise. It had then been necessary also to investigate the possibility of crew error.

All the world around aviation is carried out in accordance with commonly accepted rules. These have been formulated by ICAO (International Civil Aviation Organization) and made regulations by the member states. Among other things these rules imply that the pilot files a flight plan before take-off. Vital information from the flight plan is transmitted to all control units that will be affected by the flight. Based on the flight plan a clearance is prepared and transmitted to the flight before take-off. Take-off, climb, altitude changes, descent, approach and landing is made in accordance with clearances given.

During flight continuous radio watch is maintained, position reports are sent at regular intervals, and when the flight proceeds through different areas of responsibility it is turned over from one control unit to the other. These procedures function very well everywhere, they did so in 1961 and in Africa with one exception — the Congo.

The United Nations maintained a large fleet of transport aircraft in the Congo. The UN air operations, however, did by far not meet with the ICAO standards. When UN planes appeared over surrounding states they often constituted a hazard to organized aviation. The UN operations

were known to be invariably most unorthodox as the planes might enter control areas without prior notification or in other cases when a flight plan had been received and communication was maintained with the place of destination the plane appeared at another place some three hundred miles away calling for landing instructions.

The nature of the civil air operations being conducted by aircraft under charter to the United Nations was observed by IFALPA (International Federation of Airline Pilots Associations). At an IFALPA-congress in 1962 a resolution was adopted which was brought to the notice of the Secretary General of the UN. In the resolution IFALPA strongly urged the UN when operating their own means of air transportation to operate in accordance with ICAO rules.

ICAO is an institution under the United Nations.

The state of affairs of the UN air operations in the Congo is not discussed in any of the Ndola reports although this would have been proper.

The accident flight was by no means an exception from UN routine. The UN Air Commander in Léopoldville knew only 45 minutes prior to take-off that destination was Ndola. The pilot in command did not have the intention to file a flight plan. He was, however, persuaded to do so—but for flights to Lubumbashi. He received no briefing. The flight was undertaken with no apparent information on the weather conditions en route. For more than four hours after take-off complete radio silence was maintained. A large distance in Africa was flown without any person, other than the crew, knowing what was the route or intention of the flight.

These circumstances are mentioned by the investigators, but no comments are expressed.

Did security measures justify this sort of flying? — The plane was civil. The pilots were issued with civil pilot's licences re-

bring them to operate in accordance with civil air regulations — or, if impossible, to refrain from flying.

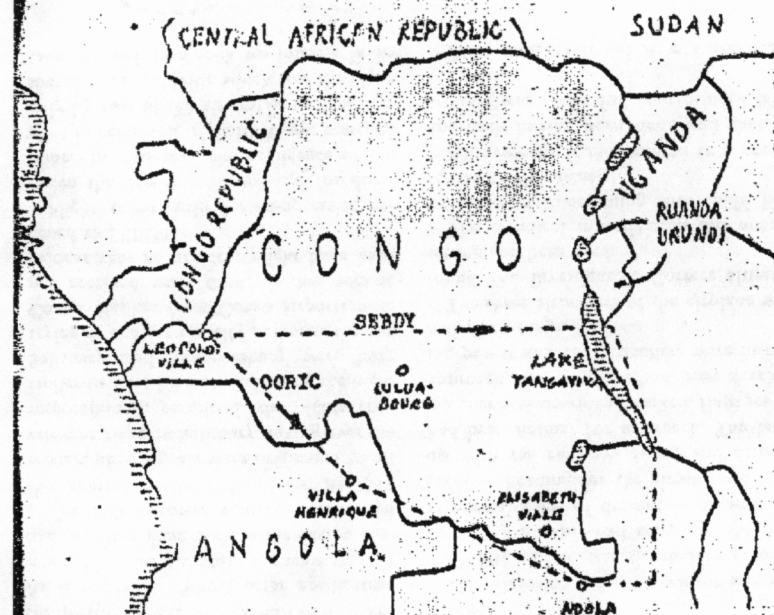
The above mentioned conditions of flight mean that the crew, at its own discretion, exposed its passengers to severe danger.

The two flights to Ndola

The same evening another flight was made between Léopoldville and Ndola by SABENA DC-4 with registration letters OORIC, and with Lord Lansdowne from Great Britain as passenger. Lord Lans-

downe offered Hammarshjöld to join him on his plane. Unfortunately Hammarshjöld declined. The captain of OORIC filed a flight plan for Ndola. The flight was carried through in a routine manner and in

FIG. 1



	OORIC	SEBDY	
Departure Léopoldville	1504	1551	GMT
Arrival Ndola	2035	2210	GMT
Flight time	5:31	6:19	Hours: Minutes
Distance flown	1120	1735	Miles

GMT = Greenwich Mean Time
Léopoldville time = GMT + 1
Ndola time = GMT + 2

full radio contact on the almost direct track via Villa Henrique in Angola. Departure signal was made and the appropriate control units — including Salisbury and Ndola — knew about the flight beforehand. The plane landed without incident at Ndola after five and a half hours of flight.

Half an hour before the landing of OORIC, Salisbury Flight Information Center was called by an aircraft identifying itself as SEBDY and asking for information about OORIC. On request from Salisbury SEBDY gave its destination as Ndola, aircraft type DC6 and place of de-

parture Léopoldville. Later it reported being over Lake Tanganyika. Neither Salisbury nor Ndola had received any advance information about this aircraft which two hours later arrived over Ndola coming from the east. SEBDY departed Léopoldville 45 minutes later than OORIC and arrived over Ndola 1 hour and 35 minutes after the landing of OORIC. Although it was 30 % faster, SEBDY used 15 % longer flight time. The route taken by SEBDY has been reconstructed and is shown — compared to that of OORIC — in fig. 1. It is to be noted that SEBDY flew through Nairobi Flight Information Region without reporting this to Nairobi.

The accident

Although there was no information to that effect, it was believed at Ndola airport that Mr. Hammarshjöld was on board SEBDY. As the plane neared, the Ndola weather and altimeter setting was transmitted to it, and upon request it received a clearance to descend to 6000 feet. In aviation altitudes are always given with reference to the sea level. The elevation of Ndola is 4160 feet. Flying over Ndola at an indicated altitude of 6000 feet — using Ndola's altimeter setting — the actual height above the aerodrome is 1840 feet.

The Ndola weather was fine with no clouds, slight smoke haze, visibility 5 to 10 miles. A slight wind was blowing from the east, and this meant that landing was to be performed towards the east on Ndola's west-easterly runway.

The captain of SEBDY asked for descent clearance at an early stage. It is very probable that his intention was to come in over Ndola parallel to the runway with reduced altitude and speed in order to perform a normal landing circuit. Approach and landing would then be just a routine matter.

SEBDY originally gave its estimated

time of arrival as 2235 (Greenwich Mean Time Ndola time = 0035). It was later altered to 2220.

At 2210 SEBDY reported lights in sight, overhauled Ndola descending, and asked for confirmation of the altimeter setting. The Ndola tower controller once again gave the altimeter setting and told the plane to report when reaching 6000 feet.

Meanwhile OORIC was getting ready to take off for continued flight to Salisbury. The controller would have to see to it that separation was maintained between the two aircraft. He was expecting SEBDY to call again reporting 6000 feet. He would then issue instructions for the approach. As he did not hear from the plane he called it at 2215. There was no answer.

OORIC now had its engines running. SEBDY was unsuccessfully called several times both from the tower and from OORIC. The controller believed that SEBDY was somewhere west of Ndola and above 6000 feet. At 2230 OORIC was cleared for take-off and instructed to fly eastwards keeping below 6000 feet while in the vicinity of Ndola.

What had happened to SEBDY? — Ra-

dio failure was out of the question. In that case the plane would have returned to the airport at its last assigned altitude, 6000 feet, awaiting light signals.

There is no high terrain around Ndola. There were no obstructions at 6000 feet or above. As the plane was above 6000 feet it was obviously safe. At first the controller thought that the pilot had changed frequency and was trying to contact some station in the Congo.

There was, however, a logical answer to the question of the whereabouts of SEBDY. As it appeared without prior notification it was likely to disappear the same way. It had probably gone back to the Congo.

The Ndola tower controller consulted the control center at Salisbury. At 2342 request news signals were originated to all relevant airports. Salisbury, taking over the responsibility, permitted the Ndola controller to close his station. During the night Salisbury and Johannesburg were busy trying to contact the UN authorities in the Congo. Replies from Congo airports were not received until 0544. It then became evident that an accident might have happened to SEBDY.

Flight safety calls for co-operation between the parties involved and for discipline. In this case, the negligence of the pilot in command of SEBDY was matched only by that of the air traffic control personnel at Léopoldville which saw the plane take off and then took no interest in its

further destiny. Now the plane was missing — and where was it to be found?

It is not to be wondered at if the search from Ndola started half-heartedly. The first aircraft was sent out at 0700. The activity increased during the day. As it was believed that SEBDY had returned to the Congo — where it probably was to be found — the search was directed towards the Congolese border. It was a complete surprise when the wreckage at 1310 by chance was found 9 miles west of Ndola airport.

The elevation of the accident site was 4357 feet and it was situated in desolate bush. The aircraft had contacted the trees at normal angle of descent — about 3 degrees — heading for the airport and lined up with the runway. Speed and attitude had been normal for approach. The landing gear was down and locked, flaps set for approach, all 4 engines had been developing power and the propellers were in normal pitch range.

The three altimeters of the airplane were found and investigated. Correct altimeter setting had been used.

The technical investigation did not reveal any malfunctioning that could have caused the accident.

All evidence found pointed to a normal approach having been done and that the aircraft was under full control until it hit the trees.

From watches found it was established

that the accident occurred at 2215, three minutes after the last radio contact. When the controller called SEBDY at 2215 it had already crashed.

Several witnesses were found who had observed the plane until 20 or 30 seconds before the crash when it apparently went below their line of vision.

Accident theory

It was established that SEBDY in fact did execute an approach the only abnormal things being that no report was given at 6000 feet, that this altitude was left and the approach started without a clearance, and that the aircraft in a visual descending procedure was brought too low.

How did this come about? — It is not very difficult to explain. The investigators must have been pondering over the question. As nothing is to be found in the accident reports, an explanation is given here.

In the last radio report it was stated that the aircraft was in descent. The altimeter setting was checked. Consequently the altimeters were under control. The tower controller requested the plane to report at 6000 feet which was acknowledged by a "roger". The conclusion is that when SEBDY reported over Ndola it was above 6000 feet descending.

The last estimated time of arrival transmitted from SEBDY was 2220. The actual arrival was at 2210. A timing of the descent so as to be down at 6000 feet — the initial approach altitude of Ndola — ten minutes before arrival would have been extremely bad airmanship. The aircraft arrived ten minutes before its estimate. This is another indication that the altitude was in excess of 6000 feet on arrival.

When position reports are made during descent altitude indication is usually given as e.g. "8500 feet descending to 6000". In the last report from SEBDY only the word

It was found that SEBDY had passed over Ndola, coming from the east, heading for the radio beacon two and a half miles west of the field. It had then made a right turn, to a north-westerly heading, and after flying in this direction for a while made a left turn. SEBDY flew in a pattern similar to the instrument let-down procedure of Ndola (see fig. 2).

"descending" was used. This may be an indication that a high rate of descent was maintained.

SEBDY arrived over Ndola earlier than expected and with excess altitude. This is also an indication that the last part of the descent down to 6000 feet may have been made at an increasing rate.

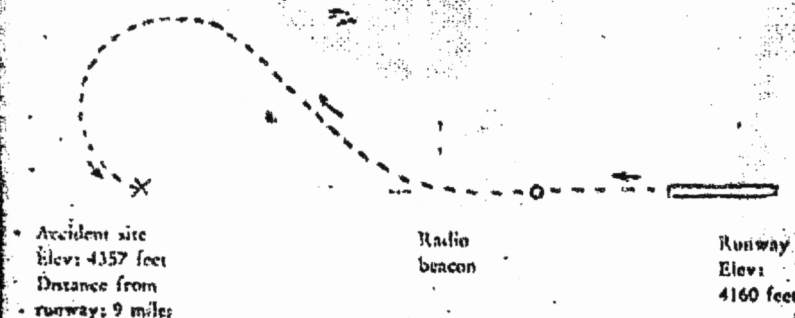
When arriving, the aircraft was in descent. This means that it had excess speed. The speed may have been up to Normal Operating Limit Speed — 245 knots. Maximum speed for landing gear and flaps extension is 165 knots. To bleed off excess speed the aircraft is held at constant altitude with power off. The procedure may have taken 40 seconds in this case.

The tower controller never saw SEBDY. The position of the crash site and the time elapsed between the last radio message and the crash indicate that the aircraft had just passed the radio beacon when the last report was made.

If the radio beacon was passed at 7000 feet or above it may very well have taken up to two minutes to complete the descent to 6000 and reduce the speed to 165 knots. This would have been the case whether the descent was rapid at high speed or slow at low speed.

After passing the airport the aircraft was headed out over an uninhabited, completely black area with no ground references.

In this situation a careful pilot would have asked for a clearance to return to the



field in order to make a normal landing circuit. He would no doubt have been cleared accordingly and told to report on down-wind leg. He would then have made a left turn back to the field, arrested the descent at 6000 feet and let the speed drop off. When circling the field he would have lowered the altitude to circuit height — field elevation plus 1200 feet — in this case 5400 feet. He would have positioned the aircraft on down-wind leg parallel to the runway flaps set at 20 degrees maintaining a speed of 140 knots. When abeam the runway end he would have lowered the landing gear, soon afterwards starting a descending left hand turn down to the runway. This is the most simple and safe method of approach there is and every pilot is trained in it. The crew would have had plenty of time to prepare itself for the landing and the final approach would have been made close to the runway thus greatly eliminating the risk of erroneous judgment in height.

Other pilots would have asked for a clearance to make an instrument approach. When passing the radio beacon they would have turned 45 degrees right to a north-westerly heading. After 45 seconds they would have started a left hand turn back to the field. During the procedure they would have stopped the descent at 6000 feet and let the speed drop off. At 165 knots flaps would have been set to 20 degrees. After the turn back the correct moment to start final let down would have been judged by observing the runway lights. The descent would have been started by lowering the landing gear, the aircraft would have been lined up with the runway and the altimeters carefully checked during final approach. During the procedure turn the aircraft would have been as far away from the field as 8 to 9 miles.

This is the instrument approach modified for flight with visual reference to the ground. Under the prevailing circumstances it was certainly the fastest way to land

at Ndola. This type of approach calls for greater pilot skill, good cockpit co-operation and the pilots would have to be very attentive.

Many pilots would have a tendency to extend that part of the procedure when the aircraft is flown out from the radio beacon. It is difficult to judge the distance travelled when the runway is behind and cannot be seen and — after starting the turn back — the pilot does not like to find himself close and high which would force him to make a steep final descent.

The altitude in this case being 6000 feet — 600 feet above normal circuit height — is a factor that may predispose the pilot to believe that he is high.

Soon after starting the left turn the pilot gets the runway in sight and tries to estimate the distance to it. During daylight or if flying over a lighted area this may very well be done. But as the conditions were at Ndola the terrain below and between the aircraft and the runway was in complete darkness. Under such conditions it is impossible to judge the distance with any degree of accuracy. If descent is started the altitude should be decreased with decreasing distance to the runway. And under the above related circumstances it was quite impossible to judge the height.

A strict adherence to the instrument approach procedure would not mean much difference. Then it is supposed that the aircraft is flown out from the radio beacon at approach speed, and as the procedure is timed the pilot knows the distance from the radio beacon expressed in minutes and seconds. The general idea, however, is that final descent should be started when inbound and at a distance from the runway of about 6 miles. It should be stopped at minimum altitude — field elevation plus 500 feet, in this case 4700 feet. This altitude should be kept until the radio beacon has been passed inbound and until close to the runway. The procedure has been laid down for approach under bad weather

conditions — low overcast or poor visibility.

A dangerous situation may however arise if the approach is made in fine weather and the runway is visible to the pilot, especially if he is not informed on the effects of optical illusions, if he is tired or if the approach is made in a hurried manner. The pilot may then tend to concentrate on the runway lights, base his judging on the impression he gets from them and disregard the altimeter. By help of false impressions he may thus get too low and hit the ground. Many accidents have occurred this way.

SEBDY crashed 9 miles west of Ndola. At this point it should still have been at 6000 feet. There were indications at the crash site that SEBDY might just have come out of its left turn when it hit the ground. Flaps were set to 30 degrees, as for final approach. In all probability the landing gear has been extended and the flaps set to 20 degrees when the left turn was started, flaps 30 having been selected at a later stage. When SEBDY was outbound from the radio beacon the pilot flew on instruments. It is more likely that he was able to maintain his altitude during this stage of the approach than later when he got the runway in sight.

When SEBDY arrived over Ndola, six hours of monotonous flying was to be succeeded by the few minutes of vigorous and precise activity required for approach and landing. While the captain was flying and giving the orders, the copilot was to read the checklist, make the necessary radio contacts and assist the captain. The flight engineer was to check the items called by the copilot and respond to orders from the captain as to power settings, gear and flaps settings.

The plane arrived earlier than expected. It is possible that the captain, copilot or flight engineer was not seated in his respective position at that moment. Anyway, the early arrival was a surprise to the crew which might also have felt the burden of

the importance of the flight which had not been undertaken in the regular manner coincident with normal passenger flight.

When the position over the radio beacon had been established the captain told the copilot to make the radio report. At the same time he started a right turn to a north-westerly heading. This action was quite normal whether he intended to make an instrument approach or to join the Ndola holding pattern. He ordered the copilot to read the Before Landing Checklist. From the moment the radio beacon was passed until the aircraft was positioned on its new heading 45 seconds elapsed. In this time the position report was made and the altimeters checked. The captain arrested the descent at 6000 feet and started to bleed off excess speed by maintaining the altitude with a low powersetting.

It is possible that the captain at this moment told the copilot to report that 6000 had been reached and to ask for permission to make an instrument approach. The copilot, who had just made a report, thought that he could first complete the checklist until the point where the landing gear is extended and postponed the transmission. Gear down was, however, ordered before he had come this far in the checklist and he then continued with the checklist in its entirety forgetting, or further postponing his radio message.

Consideration must be taken to the fatigue of the crew members who were not prepared to undertake the flight. The signs of fatigue are distinct. There is a slow down in mental work. Although things are being done slower they are not being done more correct. When the actual situation demands actions at a rate so fast that mental work is left behind the individual will skip actions or postpone them and he will also jump to conclusions. In such a situation anything may happen. Where several persons are involved co-operation may be ruined.

The facts that SEBDY had been cleared

down to the initial approach altitude of Ndola and that there was no radio communication with others might have made the captain aware that there was no other traffic around. It is possible that he intended to start the approach, complete all the preparations for landing and then just report that he was on final approach. Such a line of action would coincide with the drawing up of the whole flight, and also with a testimony of a witness to whom the captain had given his opinion of air-traffic control services.

After 45 seconds on a north-westerly heading the captain started a left turn. Due to insufficient experience of the aircraft type he thought that he was quite near the runway. He knew he was pretty high. Just before the turn was started or soon afterwards the speed was down to 165 knots. He then ordered "Gear down" and "Flaps 20". He let the speed drop further to 140 knots.

The search

It is natural if one wonders over the inactivity of the Ndola tower controller after the crash. Such a line of thought is, however, biased by the fact that one already knows what had happened. At the time when it occurred, accident was the last thing the controller would think of. He and the Rhodesian air traffic control service proceeded in accordance with regulations laid down in case of interruption of communication with aircraft. No criticism is directed towards the Rhodesian air traffic control service in the accident report.

The captain of SEBDY was entirely responsible for the fact that the accident was not immediately discovered. By starting the approach without a clearance, without even giving notice, he put the whole security system out of function. This matter is not discussed by the investigators.

Under ordinary circumstances Léopold-

During the turn he got the runway in sight. The conditions were ideal for an optical illusion. A contributive factor may have been that the Ndola runway is very narrow. Deceleration in forward speed and acceleration downwards due to the turn contributed to a complete sensory illusion which made the captain believe that he was too high. He ordered "Flaps 30", kept the power setting low and went into a descent of more than 1000 feet per minute. The co-pilot being overstressed failed to check the altimeter and went on with the check list. The captain, eyes on the lights, lessened the turn to line up the aircraft with the runway. Being satisfied that he was now on correct glide path he increased power. Keeping the correct approach speed he hereby raised the nose of the aircraft, and thus, still being the victim of an optical illusion, the captain thought that the aircraft was fully safe when it descended into the ground.

ville should have awaited an arrival message from Ndola. In this instance when a flight was dispatched under the most abnormal conditions that message should have been eagerly expected, and Lubumbashi, Kamina and Elisabethville should have been kept alert until it was known that SEBDY had landed. Nothing of the sort happened and Léopoldville closed its station for the night causing delay in the search for SEBDY. The matter is not taken up in the accident reports.

On the other hand individuals not belonging to the air traffic control service are being criticized. The British High Commissioner in Rhodesia and the Ndola airport manager were to receive Mr Hammarskjöld. When he did not arrive they thought that Mr Hammarskjöld had changed his mind for political reasons, and returned to the Congo. The idea was conveyed to the

controller. The "interference" is discussed in the report of the Board of Investigation. As this report was the basis on which the hearings were made before the Federal Commission of Inquiry and the UN Commission, the same discussion is to be found in the reports of these two bodies.

Transair

At the time of the Ndola accident the owner of SEBDY, Transair Sweden, was in an expansive stage. Operation for the United Nations had just started and was to be greatly increased. The company was in an economically sensitive situation. Against this background one understands the active part played by the company in connection with the investigation.

The same day as the accident was known the president and the flight operations manager of the company appeared on Swedish television and radio at best listening hour. This was when the shooting-down theory was set about, a masterpiece of PR-work. The public got exactly what it liked. Nobody thought of the fact that the two gentlemen were not in the position to know more than any other person in Sweden. And later when Transair put its theory forward to accident commissions it certainly got headlines.

Should SEBDY have been forced down by an air attack there was but one plane to connect with that attack, namely the Katangese Fouga Magister, a small French-built jetplane designed for training and private flying. Its base was visited by the investigating board. It was found out that the Fouga had never flown over Rhodesian territory without permission, it had not flown on September 17th, it had never flown during night as it was not equipped for night flying and it did not have the range to reach Ndola.

To arrange a rendez-vous west of Ndola,

The Board of Investigation consisted of technical and operational experts. It is ridiculous how these experts bring up a matter as the above mentioned and at the same time withhold all matters dedicated to shed light on the accident. One is forced to believe that the Board of Investigation served as a bespoke department.

identify and attack SEBDY without being observed would have been extremely difficult, especially taking into consideration the uncertainty as to the expected time of arrival of SEBDY. To shoot the plane down without leaving the smallest piece of evidence would have been impossible.

The normal approach pattern flown by SEBDY does not fit with an attack. Nor does the extension of landing gear and flaps. If these were extended and the plane attacked the pilot would rather have retracted gear and flaps again. Instead an additional 20 degrees of flaps were set as for final approach. Nothing but poor judgment by the pilot can explain the low altitude at commencement of final approach. If being attacked the pilots would have told us over the radio. The plane was in one piece and under full control when it hit the ground.

The technical investigation revealed in prior to accident malfunctioning in any part of the plane. The bodies of the individuals responsible for flying the aircraft were examined. No bullet wounds were found. The crash site, the terrain around and beneath the path flown by SEBDY was searched for evidence of shooting. Nothing was found. A world leading criminologist was engaged by the United Nations. After a comprehensive and meticulous investigation he rejected all theories of shooting down, sabotage and technical defects, and declared that the accident was due to pilot error.

It is easy just to assert that the plane was shot down or exposed to sabotage. But it is difficult to present a detailed theory worth a trial. Transair tried. The company put its best technical and operational brains at work, decided for the shooting down line, and came out with a theory which, however, did not stand the test before any of the commissions. And yet, Transair was in a very good position as personnel from the company took part in the technical investigation, and first hand information was thus at all times available.

However unrealistic and fruitless the speculations about shooting down and sabotage have been they have served a major purpose. That is to draw the attention from the natural explanations of the accident.

Test flights were made in order to check on testimonies given by witnesses who saw SEBDY on the accident night. Transair (what else?) put a plane and a crew to disposal. As a result of the test flights it was considered a possibility that SEBDY might have been lower than 6000 feet already when it passed over the field.

If SEBDY really was that low, and to the knowledge of the captain, there was no reason for the wide approach made west of Ndola.

If the plane was low due to misreading of the altimeters or misunderstanding of the elevation of the airport, one can only say that the plane was bound to crash.

Concerning the testimonies in this respect, either the crew of SEBDY was tremendously incompetent or the witnesses were wrong.

It is very difficult to judge the height of an overflying aircraft. In this instance the witnesses were to compare the height of the test plane with that of SEBDY. When they saw SEBDY its height did not mean a thing to them as they did not know that

they were to compare it with another plane's height several days later.

The captain of the test plane was flight operations manager in Transair. Not the one who was on TV. This was a new one, and number two in a row of three in a year. On one occasion he showed me a photo which he had taken on a day-light approach to Ndola. He told me that he was on his way to the Swedish Board of Aviation. By help of the photo he would explain that there could have been no misjudgement of the height by the captain of SEBDY.

To me that photo meant quite the opposite. There was the flat desolate bush west of Ndola, exactly the type of terrain into which planes descend in similar accidents. On approach during night it is as flying over a black hole, the pilot knows that there are no obstructions below, he judges his height by the runway lights ahead and descends into the ground.

I do not know what the result was of the talk at the Board of Aviation.

The interesting point is, however, that the captain of the test plane 10 years earlier served as copilot on a DC-6 which, on approach to Cairo under conditions similar to those at Ndola, hit the ground. A main landing gear broke off and the plane bounced into the air again. The pilots made it to the runway where the plane crashed. The passengers and the crew were saved.

No test flights were made at Ndola in order to find out about the possibilities for misjudging the height.

Once I asked flight operations manager number three of Transair about his views on the Ndola accident. That was before his Transair start, when he was still with the Civil Aviation Board. He was very reluctant. His only comment was that the accident had become a political issue.

The press

In dealing with the Ndola accident the Swedish press wasted a lot of printer's ink on sensational stuff of no value. Very little of factual information was given. The experts on aviation were disregarded. If the press had been the least interested in what the Swedish Pilots Association had to say it would soon have found out what was wrong with the investigation.

At an early stage of the investigation it was found that some of the bodies after the persons who had been on board SEBDY contained bullets. The big news struck down on the public. Swedish criminal experts were dispatched to the battle-field in order to secure the evidence. After a few days very little was heard.

The bullets were quite normal. On board SEBDY were some armed UN soldiers. They carried ammunition for their machine-guns. When the plane crashed and caught fire the ammunition exploded. Thus some of the bodies contained not only bullets but also cartridge-cases. The injuries were very superficial. It was established that none of the bullets had passed the bore of a weapon.

Testimonies by Africans who had seen "a small plane behind the big" was another matter to waste even editorials on.

If the Swedish criminal experts at the scene had been asked the whole thing could have been dropped at once. Any person may get confused by the navigation and anti-collision lights of a big passenger aircraft. The testimonies were changed every now and then. Some of them referred in time to the landing of OORIC. Some of the witnesses saw the crash and did not report it, others looked the place hours before the wreckage was discovered.

The newspapers missed the interesting point though. The witnesses were found in Ndola beer-halls and brought forward by a Swede by name Mattson.

When the Swedish government — hand

in hand with the UN — announced that it would not be represented in the Rhodesian Public Commission of Inquiry this was cheered by the Swedish press as a wise decision.

According to valid international agreements the Rhodesian commission was the correct body to deal with the case. International rules were, however, disregarded. A UN commission had been formed and its report was awaited with high-strung expectations.

To see how the UN report was received by the Swedish press it may be suitable to refer to the Dagens Nyheter (the Daily News), Sweden's biggest morning paper.

The news were presented under two page-wide headlines: "Sharp criticism by UN investigators against the aviation authorities of Rhodesia" and "The Ndola catastrophe a completely unsolved mystery".

The first headline refers to the criticism directed towards the British High Commissioner in Rhodesia and the Ndola airport manager. The newspaper pretends that the UN commission has come across something entirely new. The criticism is an exact copy of what was long before stated in the reports from the Board of Investigation and the Rhodesian Commission of Inquiry.

Two individuals, one of them not at all connected with aviation authorities, none of them active in the air traffic control services, are by the Dagens Nyheter converted to "the aviation authorities of Rhodesia".

No commission criticized in any way the Rhodesian aviation authorities which were found to have acted exactly the way one could expect, considering the actual situation, and in accordance with regulations laid down.

Talking a lot of matters as the above mentioned is of course an excellent way to avert the attention from what is essential.

In an editorial the next day the Dagens

Nyheter insinuated that the Ndola controller gave SEDDY incorrect altimeter setting.

Here was a situation when it was considered appropriate to advertise the capability of Swedish pilots, Swedish investigators, Swedish authorities, Swedes in general, and this could very well be done by

pointing out the incapability of foreigners. It did not matter if this was done by an untruthful accusation. There would be no one willing to correct it. — There was, however. It was done by kicking the Aviation Board into operation. The day after the Dagens Nyheter had to print a rectifying note signed by the head of the board.

The Investigation

Aircraft accident investigations are made in order to find the cause. In so doing one has the tool by which it may be possible to avoid further accidents of the same type.

The investigations should be accounted for in such a way that the public which entrusts itself to air transportation clearly can see that everything has been done in order to reveal any defect that might endanger aviation safety.

This is the way accident investigations are treated in for instance Great Britain and the USA. As the investigation report is made fully available to the public and distributed all around the world the investigation commission is pressed to do its utmost in order to find the cause of the accident and to make the report unquestionable.

In other countries investigations are kept isolated from public observation, the reports remain confidential and only a summing up is published. Has the accident been forgotten nothing as all is published.

As most accidents are due to pilot error the accident reports are of great value to the pilots. A wise pilot learns from the mistakes other pilots make. The one he makes himself may cost him his life.

As a result of the difference in accounting for accident investigations, American accident reports are of great advantage to Swedish pilots, while the American pilot never has the possibility to read a Swedish accident report.

In international collaboration some nations give — others take.

Dealing with the Ndola accident in legal ways would have meant that the Rhodesian authorities alone should have been responsible for the investigation. The case would then have been treated in British style. Knowing that its report would be scrutinized in every detail the Rhodesian commission would have had to come out with a full explanation as to the accident, supported by all facts with a bearing on it.

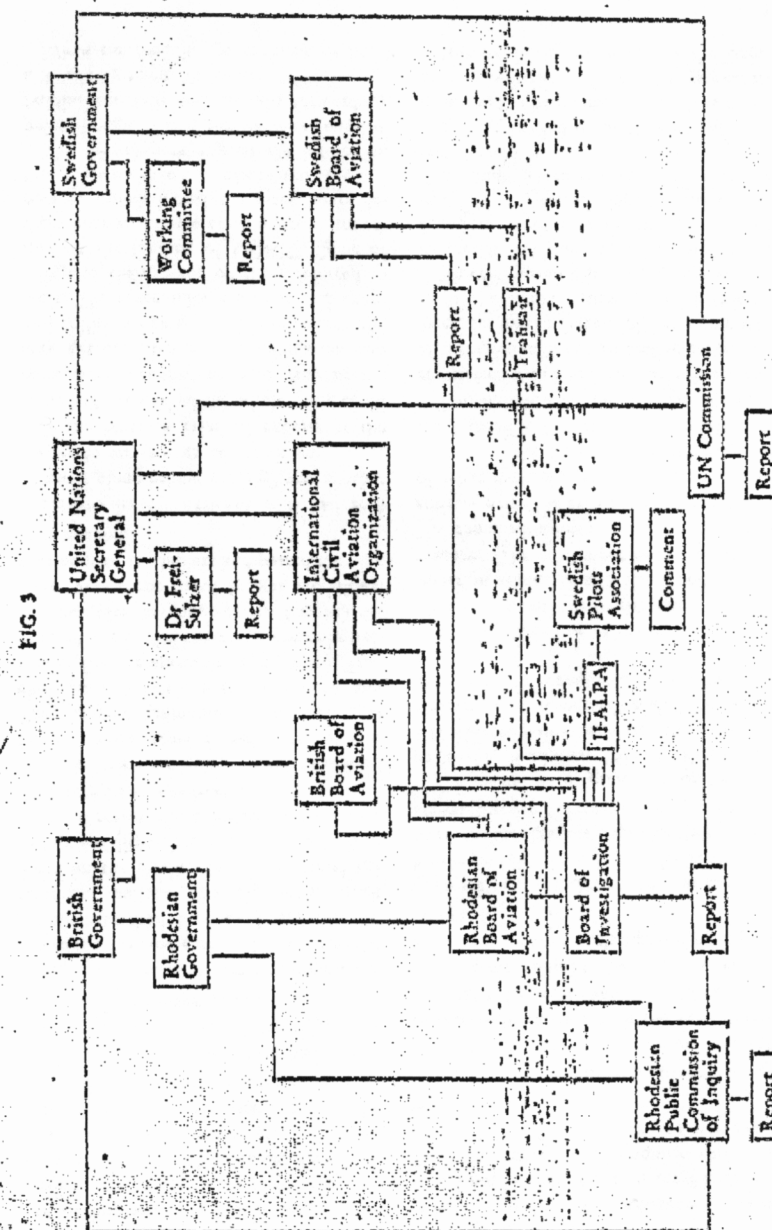
But persons representing the United Nations, the Swedish Aviation Board and Transair arrived on the scene, and under the circumstances there is not very much to say about it. To bring in Swedes in the investigation board was, however, to bring in another, strange and authoritarian philosophy.

To make things worse the UN commission was decided upon — a commission with no interest at all in finding the cause of the accident.

One can hardly blame the Rhodesian authorities that it was made a mess of the investigation.

The different authorities that dealt with the Ndola accident as well as the commissions and their reports are shown in fig 3. The UN commission consisted of persons from Sweden, Yugoslavia, Sierra Leone, Nepal and the Argentine.

The day after the accident the Rhodesian Board of Aviation appointed the Board of Investigation. Persons from the British Board of Aviation, ICAO, the Swedish Board of Aviation, Transair and IFALPA



were attached to it. This body of technical and operational experts made the investigation and prepared a report that was the basis on which the hearings were made before the Rhodesian Public Commission of Inquiry and the UN Commission.

The Board of Investigation worked on four theories that had been laid down beforehand, i.e. enemy action, sabotage, technical malfunction and pilot error. By discussing the first three of these theories and concentrating all work on them they were eliminated, and pilot error was indicated as being the cause of the accident.

It is the first time an accident investigation has been treated this way which becomes disastrous when the different theories appear again in a summing up. It was certainly so in this case as the possibilities for pilot error were not discussed and the operational data with a bearing on pilot error were missing.

The reports from the Rhodesian Commission of Inquiry and the UN Commission resemble the report of the Board of Investigation.

The Rhodesian commission established that the cause of the accident was pilot error.

The UN commission arranged the four theories in a summing up and concluded that none of them could be eliminated (take your choice).

The conclusion of the UN commission is ridiculous bearing in mind the report by Dr Frei-Sulzer.

Dr Frei-Sulzer, Chief of the Scientific Department of the Zurich Police and Professor of Science criminology at the University of Zurich was especially engaged by the UN secretariate in order to investigate into the possibilities that the plane had been shot down or exposed to sabotage. The professor made a most careful examination. In his report he states that if the plane had been shot down or exposed to sabotage he would have found out about it. He rejects

all other theories and states that the accident was caused by pilot error.

Why was the professor at all put at work?

The trials of the Ndola case before the Rhodesian and UN commissions were examined by a working committee appointed by the Swedish government. The committee expressed its satisfaction (of course) with the way the case was dealt with. It may be interesting that the committee ventured specified remarks.

About the Rhodesian commission it said: "The proceeding was in every respect public. As regards impartiality and completeness it satisfied great demands. All argumentation provided was accepted and there was no restriction in liberty of the representatives of parties to call and hear witnesses. The representatives could freely unfold their views and comment on what had been brought forth."

About the UN commission the committee noted: "Adverse remark must, however, be made on the fact that the proceeding before the commission as a rule did not include such a test of the credibility of the witnesses as, according to Anglo-Saxon standard, is made by cross-examination".

Three members of the Swedish Aviation Board who took part in the investigation have written a report in Swedish, pencilled in 20 copies and marked "Confidential". — Never mind. People are saved from reading it.

The investigation has been commented upon by a pilot expert of the Swedish Pilots Association. His comment starts as follows:

"The investigation appears to have been made with all the carefulness that is customary. Provided that the results accounted for are facts one can scarcely even suppose sabotage or shooting down as possible causes. In its aim to try to establish the possibility of these two causes the Board has, however, in my opinion, become rather prejudiced. When the Board has established

that these theories are not very probable it has refused to proceed on other matters. Some kind of analysis of the category of causes that one personally considers most

probable, i.e. the operational, has not been made, at least it has not been accounted for. In other words: the investigation is only half done!"

The sensory illusions of pilots

In the childhood of aviation aircraft were flown solely by help of the sense impressions that the pilot was subjected to. Certain instruments were soon installed, such as airspeed indicator, altimeter and compass.

This instrumentation was, however, not sufficient for flight in poor visibility. The pilot used his senses but these gave him false impressions. Instruments were designed for instrument flying. In the start the instrumentation caused the pilots difficulties. The readings were not simple enough to translate into the information needed. It happened that pilots rather believed in their own senses, and accidents occurred. The instruments were improved and new instruments designed and now, pilots have for decades been flying much more safer on instruments than with visual reference to the ground.

The instrumentation of a modern aircraft and the precision by which it can be flown on its instruments is tremendously impressive — even to the professional man.

Flying with visual reference to the ground and instrument flying are two different arts. The professional pilot must be able to master both of them. Trouble may, however, arise when there is a mixture of the two methods of flight, or when transitioning from one to the other.

This is the case when the aircraft after an instrument approach breaks the clouds, the runway lies ahead and the pilot visually makes the last part of the approach. He has, however, extensive training for the situation. Approach and runway lighting has been designed to help him in his transition

from visual flight and — above all — he is aware of the difficulties.

But, there is another situation, and ridiculously enough when flying in fine weather. That is when approaching a runway during night. If the runway is situated within an inhabited area there is no trouble. Street lighting and so on gives the pilot ground references, and if he is used to the airport he has his landmarks. The only difference from a daylight approach is that the horizon is missing. But if the approach is made over water or over a desert area there is no other outside reference except the approach and runway lights. The impressions of these may be very convincing to the pilot. If he is tired he has a strong tendency to focus his eyes on the runway — which is at an attractive distance — rather than on the mass of instruments with their dials and pointers right in front of him. He checks the attitude and height of the aircraft with regard to the runway lights, only giving the airspeed indicator quick glances.

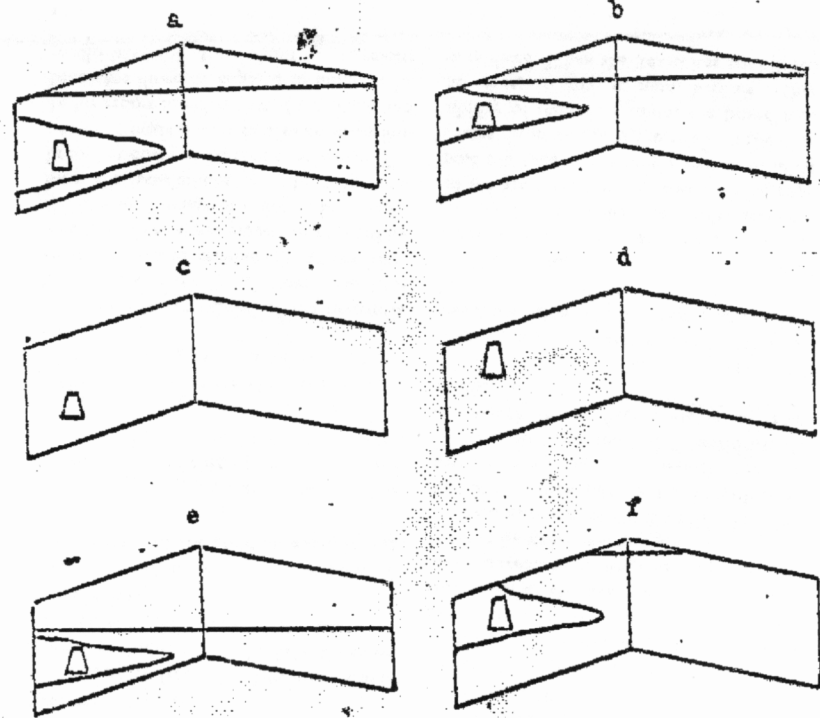
The pilot may in this way become subject to an optical illusion. In fig. 4 is shown how the optical illusion arises.

A runway situated on a tongue of land is seen through the cockpit windshield of an aircraft approaching over the water under different conditions. The distance to the runway is in all instances the same — about half a mile.

In a) and b) the approach is made during daylight. If it is considered that the aircraft is on correct glide-path in a), then it is quite clear that it is too low in b).

In c) and d) the approach is made during night. There is no horizon and no land

FIG. 4



contours. Only the lights forming the runway can be seen. It is then plausible to assume that the aircraft is on correct glide-path in c) and too low in d). The conclusion is arrived to by imagining the horizon and put it at the same place as in a) and b). It is kind of a second nature with pilots to imagine where the horizon is when it cannot be seen.

The assumption as to the aircraft's position in relation to the glide-path in c) and d) may be correct, but it may also be completely wrong.

The visual impression of c) may refer to c) i.e. the aircraft is too low and is flying in a nose high attitude, and the impression given in d) may mean that the aircraft is

on correct glide-path but in a nose low attitude as in f).

The attitude of the aircraft changes with many variables — especially speed and rate of descent — and during approach the aircraft is subject to great attitude changes.

As can also be seen from fig. 4 the runway contours give different perspectives depending on which height it is seen from. This is a condition that is used by many pilots. They carry in mind a picture of the contour the runway should form when seen from the ideal glide-path.

This method of judgment may be useful when approaching well-known runways, in other situations it may be disastrous.

This is the case when approaching a run-

way, the near end of which is lower than the far end i.e. the landing will be made up-slope. Using the above mentioned method the aircraft will then be brought too low during the approach.

Runways with proportions between length and width that are not normal will also confuse the pilot.

The glide-path forms an angle with the horizontal plane. This angle is normally 3 (three) degrees. Misjudgments as those mentioned above can be said to be caused by a misplacing of the imaginary horizon. As much as the horizon is misplaced as much will the aircraft deviate from the correct glide-path. This means that at the Ndola accident the horizon was misplaced less than 3 degrees, as the elevation of the accident site was a little higher than the runway.

The farther away one is from the runway the more difficult it is to judge the correct glide-path. The error in height caused by misplacing the horizon increases with increasing distance from the runway. A one degree misplacement of the horizon means less than 50 feet error in height at a distance of half a mile — as in fig. 4. At 9 miles distance — as at Ndola — it means 825 feet error in height.

The misjudgment so far discussed is caused purely by optical illusions. If the pilot is under the influence of acceleration forces — as he is when making a turn — the matter becomes more intricate. Other senses come into the picture and it may be more correct to say that the pilot is subjected to sensory illusions.

Any approach that is made under the conditions discussed here causes any pilot difficulties. Generally the aircraft is brought lower than desired during some part of the approach. Either the pilot at the controls or the other pilot discovers the condition, power is applied, and the aircraft is brought back to the desired glide-path.

The strange thing is, however, that there

is so little discussion — or no discussion at all — about the difficulties and their causes. At it seems, no pilot believes that he would ever fly into the ground under the conditions. And yet — that is what happens.

About 20 years ago the Instrument Landing System (ILS) was designed. The system — ground equipment as well as aircraft equipment — has been improved ever since. More and more runways are equipped with ILS. Part of the ILS is a glide-path transmitter on ground and a glide-path receiver in the aircraft. On an instrument the pilot can check his position in relation to the glide-path. The ILS was designed for bad weather approaches but it is of course used also in fine weather.

Accidents and narrow escapes of accidents have necessitated other designs. Installation of visual glide-path indicators has been going on for the last 10 years. There is a light arrangement on both sides of the runway end. Seen from an approaching aircraft this arrangement gives the pilot red light indication when he is below the glide-path.

When installing these systems priority is of course given to airports with heavy traffic and to the runways mostly in use. For many years to come there will be a great number of runways without any kind of glide-path indication.

The problem is, however, not only a matter of getting better equipment. It actually happens that pilots trust their own senses to such a degree that they disregard glide-path indications — both ILS and visual — and make the approach too low.

There is not much literature on the sensory illusions of pilots, and what there is has been published by Flight Safety Foundation Inc., New York. This is the case with a paper written by captain P. P. Cocquyt, chief pilot of SABENA airlines. Captain Cocquyt's paper is entitled "The Sensory Illusions of Pilots" and was published in 1951. It is probably still the most ex-

tensive work there is on the subject.

Since the time of the report of captain Cocquyt a great number of accidents due to sensory illusions have occurred. As probable cause has been indicated pilot error or pilot misjudgment but also sensory illusions and sometimes with a reference to captain Cocquyt's paper.

Sensory illusions do not only cause approach accidents, but also take-off accidents. And, in how many accidents have sensory illusions been a contributory factor?

The fact that accidents occur due to sensory illusions is disturbing. Not so much to authorities or airline operators as to pilots with a conscience. Warnings to fellow pilots have been produced. This was the case

with an article by M. B. Spaulding Jr. in Business Commercial Aviation, January 1959. Referring to eight recent accidents the author pointed out how "Visual Cues Can Mislead You".

What can be done to avoid accidents due to illusions? — Airport equipment and aircraft instrumentation is being improved. But in 1951 captain Cocquyt mentioned other items:

"A most comprehensive study of the different phenomena of illusions and their consequences." — When will that study be made?

"Take effective steps to make flight personnel aware of the danger of illusions." — Well, how many pilots have seen captain Cocquyt's paper?

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